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PRESENTACIóN MURAL

New field decontamination method based on variable cells in the cluster Colour-Magnitude Diagrams

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Abstract. We have designed a procedure for cleaning the cluster CMDs from the unavoidable star field contamination which makes use of variable cells in the CMDs. The cells are adjusted in such a way that they result bigger in CMD regions with a scarce number of field stars, and viceversa. This way, we reproduce the field CMD as closely as possible to the cluster CMD. The method does not need to know whether a star is placed close to the cluster centre nor the cluster radial density profile to infer a membership probability. However, it takes into account the star field density, since the more populous a star field the larger the number of stars subtracted from the cluster CMD. As a result, the intrinsic spatial star distribution is uncovered within the object region. Once the field CMD is adopted, the method defines a free path for each field star as the distance to the closest star in the field CMD. The method has shown to be able to eliminate stochastic effects in the cluster CMDs caused by the presence of isolated bright stars, as well as, to make a finer cleaning in the most populous CMD regions.

Resumen. Presentamos un nuevo procedimiento para limpiar los Diagramas Color-Magnitud (DCM) de cúmulos estelares de la contaminación de estrellas del campo, que hace uso de celdas variables. Las celdas son ajustadas de tal modo que ellas resultan más grandes en regiones del DCM con escaso número de estrellas, y viceversa. De esta manera, conseguimos reproducir mejor los DCM del campo en los DCM de los cúmulos, y extraer los DCM intrínsecos de éstos. El nuevo método no requiere conocer si una estrella se encuentra próxima al centro del cúmulo ni la distribución espacial para inferir una probabilidad de pertenencia al cúmulo. Sin embargo, tiene en cuenta la densidad estelar del campo, ya que mientras más poblado es un campo más estrellas son subtraídas del DCM del cúmulo. Como resultado de ello la genuina distribución espacial del cúmulo queda revelada. Una vez adoptado el DCM del campo, el método define un camino libre para cada estrella como la distancia a la estrella más cercana en el DCM del campo. Este procedimiento ha mostrado ser muy eficaz en eliminar estrellas brillantes aisladas y realizar una limpieza más fina en las regionas más pobladas del DCM.

Description of the new method and results

From our experience in cleaning the field star contamination in the cluster Colour-Magnitude Diagrams (CMDs), we have identified some situations which still need our attention. It frequently happens that some parts of the CMDs are more populated than others, so that fixing the size of the cells in the CMDs becomes a difficult task. Small cells do not usually carry out a satisfactory job in CMD regions with a scarce number of fields stars, while big cells fail in populous CMD regions.

We propose a new method which, once the field CMD is adopted, it defines a free path for each star as the distance to the closest star in the field CMD. Magnitude and colour directions are separately considered, so that $(\Delta(\text{colour}))^2 + (\Delta(\text{magnitude}))^2 = (\text{free path})^2$, where Δ(colour) and Δ(magnitude) are the distances from the considered star to the closest one in abscissa and ordinate in the field CMD. The method has shown to be able to eliminate stochastic effects in the cluster CMDs caused by the presence of isolated bright stars, as well as, to make a finer cleaning in the most populous CMD regions. In order to prevent from large non-meaningful free paths, the method imposes a reasonably large free path limit. The free path of a field star accounts for a zone of influence (rectangle) of that star in the CMD, in the sense that only the closest star inside that area in the cluster CMD is eliminated.

We selected a list of LMC star clusters with CT_1 data from Piatti (2012), for which we cleaned circular regions centred on them with radii twice as big as those estimated by Bica et al. (2008), i.e, we cleaned areas four times bigger than those of the circle of Fig. 1. This figure depicts a schematic finding chart for all the measured stars in the field of BS 265. The size of the plotting symbol is proportional to the star brightness.

The method was run four times for each object, each time using a different reference field area. **As can be expected, the more reference field areas used, the more the field variations considered.** Fig. 2 shows one of the four field CMDs used to clean the cluster region of BS 265. It was built from an equal cluster area extraction. Each open box is centred on a measured field star, and its size was fixed by the respective computed free-path. **Notice** that the boxes are bigger in regions with a scarce number of fields stars, and result smaller in more populous regions. The figure also shows the effect of considering T_1 and $C - T_1$ axes **independently**, since some boxes are rectangles instead of squares, i.e., the boxes are variables.

Thus, we obtained four different cleaned CMDs per object. When comparing those CMDs, one may find stars that have kept unsubtracted in most of the times, while other stars were subtracted in most of the program executions. The different number of times that a star keeps not subtracted can then be converted in a measure of the probability of being a fiducial feature of the candidate cluster field. Thus, we are able to distinguish stellar populations projected on to the cluster fields that have a probability P $<$ 25% of being a genuine candidate cluster population, i.e., a typical foreground population; stars that could indistinguishably belong to the star field or to the studied object (P = 50%); and stars that are predominatly found towards the candidate cluster field (P $>$ 75%) rather than in the star field population.

In order to illustrate how the method works, we have plotted with different symbols the stars in Fig. 1, as follows: filled circles correspond to stars with a probability of being a feature of the cluster field higher than 75% (black), equals to 50% (drak-grey), and lower than 25% (clear-grey), respectively. For stars inside the candidate cluster radius, three different CMDs are shown in Fig. 3, distinguishing those stars that have chances of being a candidate cluster field feature $<$ 25%, equal to 50%, and $>$ 75%, respectively. The ZAMS (solid line) and the isochrones from Girardi et al. (2002) for the age derived by Glatt et al. (2010) are superimposed with solid and dashed lines, respectively.

1. Bibliografía

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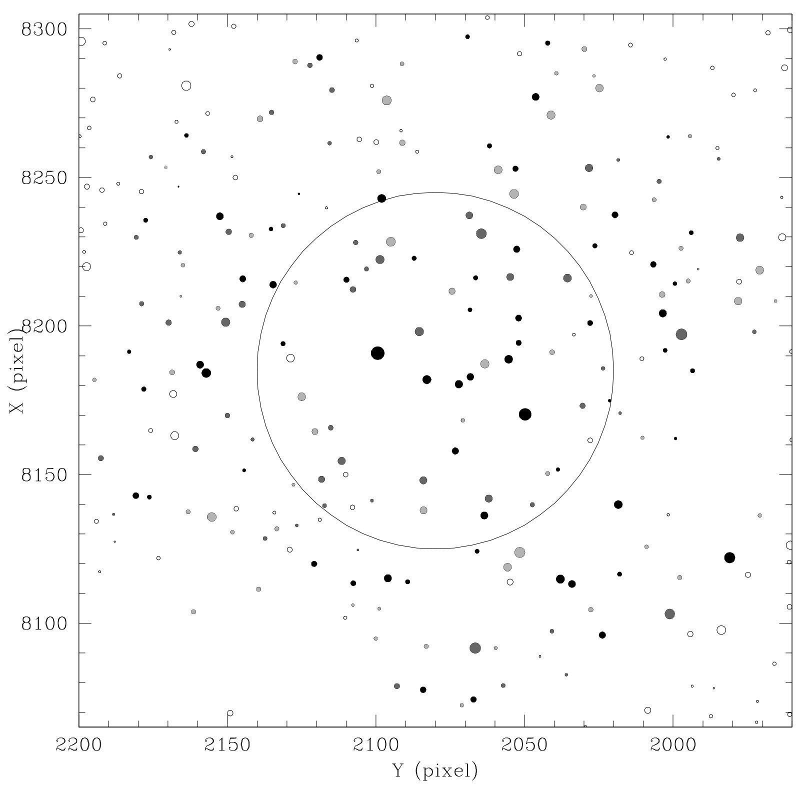

Figure 1. Schematic finding chart of stars measured in the field of BS 265. North is up and east is to the left.

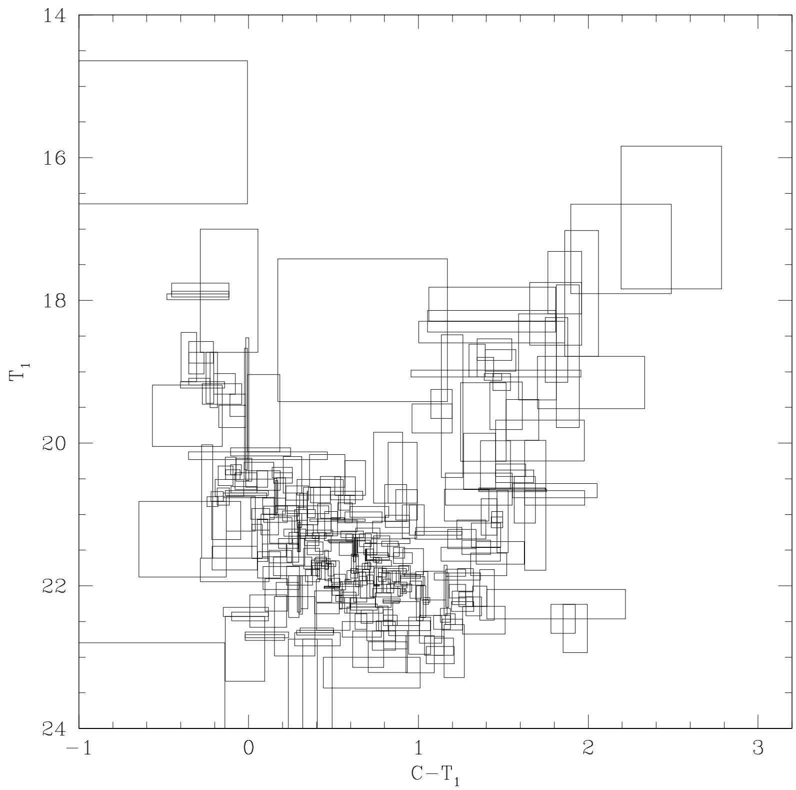

Figure 2. Field CMD for BS 265. Open boxes are centred on measured field stars and their dimensions were fixed by the free-path defined for the respective stars.

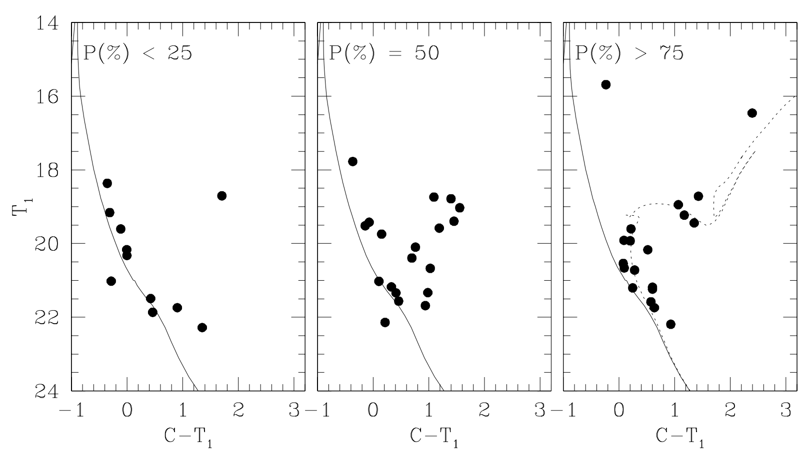

Figure 3. BS 265 CMDs for different membership probabilities.